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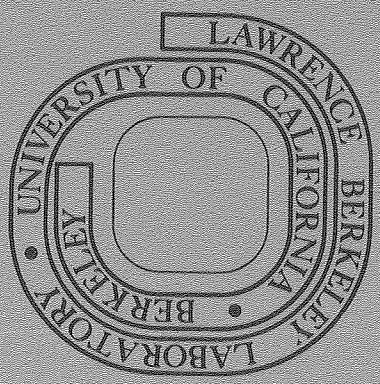

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ABSTRACT

Oceanographic studies in support of assessment and technical operations for Ocean Thermal Energy Conversion (OTEC) have been conducted in the South Atlantic Plant-ship region and at benchmark sites off Puerto Rico, the Gulf of Mexico and off Hawaii. Data has been obtained from current meter arrays, hydrocasts, and net tows using essentially the same type of equipment, sample depths, sample frequencies, techniques and analyses to provide a uniform basis of comparison among the sites. In addition, particulate, trace metal, and radiologic studies off St. Croix, Virgin Islands and primary production bioassay experiments off Hawaii were performed to validate methods and a bottom assessment program is being developed in cooperation with the U.S. Geological Survey for potential incorporation into the uniform sampling program. Environmental monitoring operations at the OTEC-1 site off Hawaii have been transferred to EG&G and the Hawaiian pre-site occupation program has been shifted to the Kahe Point area off the west coast of Oahu.

Validated data from the OTEC cruises are on file with National Oceanographic Data Center (NODC). These data are being used with the Argonne National Laboratory (ANL) developed physical models to jointly test potential ecologic models for use in pilot plant assessments. Marine geologic/oceanographic base maps and data compilation sheets were prepared for the Hawaiian and Puerto Rico-Virgin Island regions. Such sheets form a planning base for evaluation of regional characteristics and to identify areas for detailed surveys.

INTRODUCTION

Ecologically sound operations of projected OTEC plants can be insured by careful attention to the marine environment during the design phase. This requires quality information from regions of potential OTEC interest. Currently, preliminary or actual surveys and laboratory studies are being conducted in the waters of Puerto Rico, the Gulf of Mexico, Hawaii, and Guam for potential moored OTEC plants and in the equatorial South Atlantic for proposed plant-ship operations to provide such benchmark and baseline data. These data plus existing archival information can be used to model effects of OTEC operations based on projected design schemes. Four major areas of concerns (1) redistribution of oceanic properties, (2) chemical pollution, (3) structural effects, and (4) socio- legal-economic issues; and 11 key issues associated with OTEC deployment and operation have been identified. In general, mitigating strategies can be used to alleviate many deleterious environmental effects of operational problems as biostimulation, outgassing, etc., are underway or are planned to investigate areas where no clear mitigating strategy is available. A Master Plan listing procedures to be followed to identify and evaluate potential concerns at any OTEC proposed site is

proposed for discussion and refinement in advance of any real OTEC test operations.

As the OTEC program enters the hardware phase with the deployment of the one megawatt equivalent test platform (OTEC-1) in 1980, the environmental data required for permitting and eventual design for commercialization is becoming more extensive and more sophisticated. One year's monitoring at benchmark sites in the Gulf of Mexico (Tampa and Mobile); Puerto Rico (Punta Tuna); Hawaii (Kona Coast/OTEC-1); and at the grazing ship site (Equatorial South Atlantic) have been completed. Archival studies have begun for Guam and a new benchmark site (southwest Oahu) will be occupied in early 1980. Data from these sites will be analyzed to be available to aid in site selection for future test deployments.

PRESENT AND PROJECTED MONITORING PROGRAM

The monitoring strategies are design for shipboard operations, manned platforms as well as instrumented buoys. This program is to be integrated with those proposed by OTEC groups for biofouling and corrosion, and by NOAA for synoptic oceanographic parameters. An additional goal is to develop a packaged monitoring program which can be mobilized rapidly to aid in site selection for larger OTEC platforms. Data collection and monitoring strategies will be done in view of compliance with NEPA and EPA, Corps of Engineers, Coast Guard, etc., regulations.

Specifically the program initiated pre-operational studies in four areas:

Hawaii - one site near Keahole Point

Puerto Rico - one site near Punta Tuna

Gulf of Mexico - regional survey using
two station locations:
(1) west of Tampa
(2) south of Biloxi

South Atlantic - regional survey, 5-10^{o}S,
20-30^{o}W and affected zone.

In the areas considered for the moored OTEC option - Hawaii, Gulf of Mexico, and Puerto Rico - a program has been initiated to take background data required to insure that baseline information is available to evaluate the effects of OTEC on the ambient environment and to provide environmental data useful in the design of the operating system. At this time, only attractive thermal regions are known with any certainty. It is premature, therefore, to pick exact sites for potential OTEC plants until knowledge of other important environmental siting factors is obtained. Accordingly, for the initial studies each thermal region is divided into subregions in which it is expected that the basic environmental conditions relating to OTEC are spatially homogeneous, although likely to vary seasonally. To characterize each subregion a reconnaissance benchmark is located. A benchmark is defined as a

specific location, typical of a subregion, where serial data are taken and to which historical data may be referred. Because of the lack of serial, long-term records of any kind in attractive thermal regions, we believe that the benchmark approach is more valuable in the long term than initiating road regional surveys where variations in measurements may be attributed to site as well as time variability. Where substantial subregional variability is found, the benchmarks will be used as starting points for potential regional surveys. The intent of taking measurements at benchmarks is to provide data, at a specific location, which will form the basis, in conjunction with previously obtained data from the area, for defining longer term and more comprehensive environmental surveys required for the siting and permitting of OTEC plants in the designated thermal regions. Station operations at the reconnaissance benchmark sites are given in Table 1. In addition to this station operation at each benchmark, a current meter array is deployed to complement current profiler runs during station operations. Current status of monitoring operations at the sites is given in Table 2. Satellite data, when available, is used to assist the interpretation of data from the arrays. Because of costs and reliability factors, measurements for the initial surveys is mainly from survey ships rather than from instrumented buoys. The survey ship occupies each benchmark site bi-monthly for a minimum of three days with augmented sampling every four months. Sampling at each station occupation is designed to give, at a minimum, day-night variations as well as bi-monthly variations for the biologically significant parameters. Parameters sampled bi-monthly are though to have variations which may be detected at that frequency. Parameters sampled every four months are thought:

(1) to have less variation annually; or
(2) to have potential but unresolved significance to OTEC.

The augmented sampling every four months is also done to develop optimal measurement and sampling techniques for parameters which may become routine during future site occupations. Upon completion of the initial study (actually, during the surveys) the sampling frequencies and choice of parameters will be re-examined. Results from augmented samplings, from serial samplings and historical data reviews will be used to design subsequent site data collections.

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Table 1. Ecological/chemical parameters for initial one-year program

PARAMETER	STATION OPERATION	STATION FREQUENCY*	SAMPLING FREQUENCY
Temperature	hydrocast	bi-monthly	all hydrocasts
Temperature	STD,XBT	bi-monthly	4 STD, 12 XBT
Salinity	hydrocast	bi-monthly	all hydrocasts
Salinity	STD	bi-monthly	4 STD
Water Currents	current meter	continuous	one per 30 minutes
	profiler	bi-monthly	4
Light transmittance	transmissometer	bi-monthly	2 traces per cast
Dissolved Oxygen	hydrocast	bi-monthly	2 casts
Orthophosphate	hydrocast	bi-monthly	2 casts
Total Phosphate	hydrocast	every 4 months	2 casts
Silicate	hydrocast	bi-monthly	2 casts
Nitrate	hydrocast	bi-monthly	2 casts
Ammonia	hydrocast	every 4 months	2 casts
Urea	hydrocast	every 4 months	2 casts
Total Nitrogen	hydrocast	every 4 months	2 casts
Alkalinity	hydrocast	yearly	2 casts
Trace Metals	hydrocast	yearly	1 cast
Chlorophyll/Phaeophytin	hydrocast	bi-monthly	2 shallow casts
ATP	hydrocast	every 4 months	2 shallow casts
Phytoplankton census	hydrocast	bi-monthly	1 shallow cast
C^{14} uptake	hydrocast	every 4 months	1 cast
POC	hydrocast	yearly	1 cast
DOC	hydrocast	yearly	1 cast
Zooplankton census	net tow	bi-monthly	6 tows

*May change based on experience at individual site for long-term monitoring program.

Table 2. Status - 1 June 1980

	PHYSICAL MEASUREMENTS	CHEMICAL MEASUREMENTS	BIOLOGICAL MEASUREMENTS
Gulf of Mexico			
Mobile	8	6	6
Tampa	6	6	6
South Atlantic	4	2	2
Puerto Rico	6	6	6
Virgin Island	-	1	1
Hawaii			
OTEC-1	6	6	6
Oahu	1	1	1

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